BREEDING BIOLOGY OF THE INDIAN FRUIT BAT, *CYNOPTERUS SPHINX* (VAHL) IN CENTRAL INDIA[1]

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(*With a text-figure*)

Cynopterus sphinx (Vahl) breeds twice in the year in quick succession in central India, and brings forth one young during each cycle. The cycle commences in October-November and deliveries in the colony take place during the following February-March. The females become pregnant within a short time after parturition and carry the second pregnancy until June-July. The second pregnancy cycle overlaps the lactation period of the first cycle. The young one is carried by the mother for about 45 to 50 days. In the first cycle, the right side of the female genitalia is physiologically dominant, and the persistance of a large corpus luteum in the right ovary necessitates the left ovary to release the ovum in the second cycle. Although the sex ratio is balanced at birth, there is an uneven female dominant sex ratio in the total population due to the preferential mortality of the males during juvenile life. Whereas the females attain sexual maturity within five months of age, the males do not reach sexual maturity until they are at least 15 months of age.

INTRODUCTION

It is evident from the few casual observations of earlier workers that Indian megachiropterans differ considerably from their counterparts in other parts of the world in regard to their reproductive habits. The two brief reports, which are available on two species of *Cynopterus,* also point to this feature. Ramakrishna (1947) briefly mentioned that females of *Cynopterus sphinx sphinx* experienced post-partum pregnancy at and around Bangalore. Moghe (1956), while describing the embryology of *Cynopterus sphinx gangeticus* around Nagpur, made a casual reference to the possibility of occurrence of two pregnancies in a year in this species. Details of the reproductive cycles were not given by either of the authors. The absence of any detailed study on the reproductive physiology of *Cynopterus sphinx* (Vahl) in central India prompted me to undertake a detailed study of the sex cycle of this bat. The present report embodies the general pattern of reproduction and observations on some associated phenomena in this species.

HISTORICAL

The first ever detailed study on the reproduction of any megachiropteran bat was made by Baker & Baker (1936) on *Pteropus geddeii* and *Pteropus eotinus* from New Hebrides 4° north of the Equator. The authors showed that these species breed in a season corresponding to the southern autumn like most bats in both the hemispheres and on the basis of this as well as on the basis of their studies of reproduction of some microchiropteran species (Baker & Bird 1936) they not only emphasised the fact that these bats have a strictly defined

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reproductive periodicity even though inhabiting an almost unvarying tropical climate in a rain forest, but that the biological equator is different from the geographical equator, the former being approximately 4° north of the latter.

Eidolon helvum inhabiting squarely on the equator in Africa mates in a sharply restricted season in the year, but there is a very long period of delayed implantation when the blastocyst lies freely in the uterus without undergoing further development (Mutere 1967, 1968).

The above descriptions have indicated that the Megachiroptera copulate in autumn and deliver the young in the following spring — a situation common to bats inhabiting temperate and cold climates. However, the Indian megachiropteran bat, *Rousettus leschenaulti* (Gopalakrishna & Choudhuri 1977) at and around Aurangabad, Maharashtra appears to have combined in it the autumn breeding pattern of the temperate bats and the spring breeding pattern of the tropical bats by breeding twice in the year. There are, however, conflicting reports on the reproduction of *Pteropus giganteus giganteus.* Whereas this species breeds in a sharply restricted season in Ceylon (Sri Lanka) with copulations occurring during the period corresponding to northern autumn and deliveries in the following spring (Marshall 1947) [although at Ceylon (Sri Lanka) these seasons are not well defined], this species has an anomalous breeding pattern in central India (Moghe 1951, Gopalakrishna & Sahasrabudhe 1972) without a sharply defined season of copulation or delivery. On any given date different females carry embryos at different stages of development, and deliveries in the colony occur during nearly all the months of the year except probably during October to December, and there is no evidence of the occurrence of more than one pregnancy per year in each female.

The works of Ramakrishna (1951), Gopalakrishna (1954), Ramaswamy (1961), Gopalakrishna & Madhavan (1978), Ramakrishna & Rao (1977) and Gopalakrishna & Rao (1977) on several species of bats from different regions of India have revealed that different species exhibit different breeding behaviour under different ecological situations. Since some information (inadequate though) is available on the occurrence of post-partum pregnancy in *Cynopterus sphinx sphinx* (Ramakrishna 1951) at Bangalore, the present studies on the reproduction of *Cynopterus sphinx* (Vahl) at and around Nagpur have been carried out with a view to finding out if cynopterid bats have a common pattern of reproduction in different climatic conditions.

Material and Methods

Specimens of *Cynopterus sphinx* (Vahl) were collected at Nagpur, Maharashtra State, India at frequent intervals for two years commencing on 24th January, 1982 such that every calendar month is represented by several collections. Altogether 601 specimens were examined for the present report. The animals were shot down with an air rifle and the body weight of each specimen was recorded by a sensitive spring balance.

After noting down the nature of the external genitalia and the condition of the mammary glands and nipples of each female, the specimens were dissected and their genitalia and accessory reproductive structures were fixed in various ways such as in neutral formalin, Bouin's, Rossman's and Zenker's fixatives. The mammary glands of the females were also fixed likewise. After fixation for 24 hours the tissues were stored in 70% ethanol for further

TABLE 1

DATEWISE DETAILS OF COLLECTIONS OF *Cynopterus sphinx* (VAHL)

Date	Males				Females									
	Immature		Adults	Total	Immature		Adults							
	Attached	Free			Attached	Free	Non-pregnant		Pregnant					
							Non-lactating	lactating	Non-lactating		Lactating		Total	Total of males & females
									Right cornu	Left cornu	Right cornu	Left cornu		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6-1-83	–	–	1	1	–	–	–	–	3	–	–	–	3	4
8-1-83	–	4	1	5	–	–	–	–	1	–	–	–	1	6
10-1-83	–	–	1	1	–	–	–	–	1	–	–	–	1	2
12-1-83	–	1	–	1	–	–	–	–	1	2	–	–	3	4
17-1-83	–	1	–	1	–	–	–	–	3	–	–	–	3	4
21-1-83	–	1	–	1	–	–	–	–	3	1	–	–	4	5
23-1-84	–	–	1	1	–	–	–	–	3	1	–	–	4	5
24-1-82	–	–	1	1	–	–	–	–	1	1	–	–	2	3
25-1-82	–	–	–	–	–	–	–	–	3	–	–	–	3	3
31-1-82	–	–	1	1	–	–	–	–	1	–	–	–	1	2
2-2-82	–	–	–	–	–	–	–	–	2	–	–	–	2	2
3-2-82	–	–	1	1	–	–	–	–	2	1	–	–	3	4
3-2-83	–	1	1	2	–	–	–	–	3	1	–	–	4	6
4-2-82	–	–	1	1	–	–	–	–	2	1	–	–	3	4
6-2-82	–	1	2	3	–	–	–	–	1	1	–	–	2	5
7-2-83	–	1	1	2	–	–	–	–	1	1	–	–	2	4
9-2-82	–	–	4	4	–	–	1*	–	–	–	–	–	1	5
12-2-82	–	–	3	3	–	–	–	–	–	1	–	–	1	4
16-2-82	1	–	1	2	–	–	–	1	–	1	–	–	2	4
18-2-82	–	–	1	1	–	–	–	–	–	–	–	–	–	1
19-2-82	–	–	3	3	–	–	–	–	2	–	–	–	2	5
20-2-82	–	–	1	1	2	–	–	2	1	–	–	–	5	6
21-2-82	–	–	3	3	1	–	–	1	1	1	–	–	4	7

Table 1 (contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
23-2-82	1	–	–	1	–	–	–	1	1	1	–	–	3	4
23-2-83	–	1	3	4	1	–	–	1	1	1	–	–	4	8
24-2-82	2	–	1	3	–	–	–	2	1	–	–	–	3	6
25-2-82	1	–	2	3	1	–	–	2	–	–	–	–	3	6
3-3-82	–	–	–	–	1	–	–	1	–	–	–	–	2	2
4-3-82	–	–	1	1	2	–	–	2	–	–	–	–	4	5
7-3-82	–	–	2	2	1	–	–	1	–	–	–	1	3	5
11-3-82	–	2	–	2	–	–	–	–	–	–	–	–	–	2
12-3-82	2	1	4	7	1	–	–	–	–	1	1	–	3	10
12-3-83	1	–	2	3	2	–	–	3	–	–	–	–	5	8
14-3-82	1	–	–	1	1	–	–	–	–	–	–	1	2	3
18-3-82	–	–	1	1	1	–	–	–	–	–	–	1	2	3
19-3-82	–	–	1	1	1	–	–	–	–	–	–	1	2	3
20-3-82	2	1	–	3	1	–	–	–	–	–	2	1	4	7
20-3-83	1	1	1	3	–	–	–	1	–	–	1	1	3	6
22-3-82	–	–	1	1	2	–	–	–	–	–	–	3	5	6
24-3-82	1	1	–	2	1	–	–	–	–	–	1	1	3	5
25-3-82	1	1	–	2	1	–	–	–	–	1	1	1	4	6
27-3-82	–	1	2	3	2	–	–	–	–	–	1	1	4	7
28-3-82	1	–	1	2	–	–	–	–	–	–	–	1	1	3
30-3-82	1	1	–	2	–	–	–	–	–	–	2	–	2	4
2-4-82	2	–	1	3	–	–	–	–	–	–	–	2	2	5
4-4-82	2	–	1	3	–	–	–	–	–	–	1	2	3	6
6-4-82	–	–	–	–	2	1	–	–	–	–	2	1	6	6
9-4-82	1	–	–	1	1	–	–	–	–	–	–	2	3	4
11-4-82	1	–	1	2	–	2	–	–	–	–	1	2	5	7
14-4-82	1	1	–	2	1	–	–	–	–	–	–	3	4	6
14-4-83	1	1	2	4	1	2	–	–	–	–	–	1	4	8
16-4-82	1	–	–	1	–	–	–	–	–	–	–	1	1	2
17-4-82	–	–	–	–	–	1	–	–	–	–	1	3	5	5
25-4-82	–	–	1	1	–	–	1*	–	1	–	–	–	2	3
26-4-82	–	1	1	2	–	1	–	–	–	–	–	2	3	5
26-4-83	2	–	–	2	–	–	–	–	–	–	–	3	3	5
29-4-82	–	2	–	2	–	1	–	–	–	–	–	2	3	5
2-5-83	–	–	1	1	–	2	–	–	–	–	–	1	3	4
3-5-82	1	–	–	1	–	–	–	–	–	2	1	2	5	6
8-5-82	–	2	1	3	–	–	–	–	–	–	–	–	–	3

TABLE 1 (contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9-5-83	–	1	1	2	–	1	–	–	–	2	–	–	3	5
11-5-82	–	3	1	4	–	2	–	–	–	1	1	–	4	8
20-5-83	–	2	–	2	–	1	–	–	1	1	–	–	3	5
28-5-83	–	1	1	2	–	–	–	–	–	4	–	–	4	6
4-6-83	–	5	–	5	–	–	–	–	–	2	–	–	2	7
11-6-83	–	2	1	3	–	2	–	–	–	1	–	–	3	6
15-6-83	–	–	2	2	–	–	–	–	1	–	–	–	1	3
21-6-83	–	–	2	2	1	–	–	1	1	–	–	–	3	5
22-6-82	–	–	–	–	–	–	1	–	2	–	–	–	3	3
23-6-83	2	–	1	3	–	–	–	2	–	1	–	–	3	6
27-6-83	–	2	1	3	–	–	–	–	–	–	–	–	–	3
28-6-83	–	–	–	–	2	–	–	2	–	–	–	–	4	4
29-6-82	–	–	–	–	–	–	1	–	1	–	–	–	2	2
3-7-83	–	3	–	3	1	–	–	1	–	–	–	–	2	5
7-7-82	1	2	1	4	–	–	1	1	–	–	–	–	2	6
9-7-83	–	1	1	2	–	–	–	1	–	–	2	–	3	5
13-7-82	–	2	1	3	1	–	–	1	–	–	–	–	2	5
15-7-83	2	–	–	2	1	–	–	3	–	–	–	–	4	6
16-7-83	1	2	2	5	–	2	–	1	–	–	–	–	3	8
17-7-82	–	1	–	1	–	1	–	–	–	1	–	–	2	3
22-7-82	–	–	–	–	2	–	–	2	–	–	–	–	4	4
22-7-83	1	–	1	2	–	–	1	2	–	–	–	–	3	5
1-8-82	–	1	–	1	2	–	–	2	–	–	–	–	4	5
3-8-83	3	1	–	4	1	–	–	4	–	–	–	–	5	9
8-8-82	1	–	–	1	–	1	–	1	–	–	–	–	2	3
11-8-83	1	–	–	1	–	–	1	2	–	–	–	–	3	4
18-8-82	–	–	–	–	2	1	–	2	–	–	–	–	5	5
21-8-83	1	–	1	2	–	–	–	2	–	–	–	–	2	4
26-8-82	1	2	1	4	–	–	–	1	–	–	–	–	1	5
3-9-83	–	1	1	2	–	–	–	–	–	–	–	–	–	2
5-9-82	–	–	2	2	–	–	–	2	–	–	–	–	2	4
9-9-83	–	–	–	–	–	–	2	–	–	–	–	–	2	2
14-9-82	–	1	1	2	–	–	–	1	–	–	–	–	1	3
17-9-83	–	1	–	1	–	–	2	–	–	–	–	–	2	3
21-9-82	–	–	2	2	–	–	–	2	–	–	–	–	2	4

TABLE 1 (contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
21-9-83	–	1	–	1	–	–	1	1	–	–	–	–	2	3
24-9-83	–	2	1	3	–	–	–	–	–	–	–	–	–	3
30-9-83	–	–	2	2	–	–	1	2	–	–	–	–	3	5
3-10-83	–	1	–	1	–	–	2	–	–	–	–	–	2	3
5-10-82	–	1	2	3	–	–	–	–	–	–	–	–	–	3
9-10-83	–	–	2	2	–	–	3	–	–	–	–	–	3	5
12-10-82	–	2	1	3	–	–	1	–	–	–	–	–	1	4
16-10-83	–	1	5	6	–	–	3	–	–	–	–	–	3	9
22-10-82	–	3	1	4	–	–	1	–	2	–	–	–	3	7
22-10-83	–	1	1	2	–	–	–	–	1	1	–	–	2	4
30-10-82	–	3	2	5	–	–	–	–	1	1	–	–	2	7
31-10-83	–	3	3	6	–	–	–	–	–	–	–	–	–	6
3-11-82	–	1	2	3	–	–	1	–	1	–	–	–	2	5
7-11-83	–	1	1	2	–	–	–	–	1	1	–	–	2	4
11-11-82	–	1	2	3	–	–	–	–	1	2	–	–	3	6
14-11-82	–	–	1	1	–	–	–	–	4	–	–	–	4	5
16-11-83	–	3	3	6	–	–	–	–	1	–	–	–	1	7
18-11-82	–	1	2	3	–	–	–	–	3	–	–	–	3	6
23-11-82	–	2	1	3	–	–	–	–	1	–	–	–	1	4
26-11-82	–	4	2	6	–	–	–	–	1	–	–	–	1	7
29-11-83	–	2	–	2	–	–	–	–	1	–	–	–	1	3
30-11-82	–	–	–	–	–	–	–	–	4	–	–	–	4	4
3-12-82	–	1	–	1	–	–	–	–	–	–	–	–	–	1
5-12-82	–	1	3	4	–	–	–	–	5	1	–	–	6	10
11-12-83	–	4	1	5	–	–	–	–	–	1	–	–	1	6
14-12-82	–	2	–	2	–	–	–	–	–	1	–	–	1	3
19-12-82	–	2	4	6	–	–	–	–	–	2	–	–	2	8
22-12-83	–	3	1	4	–	–	–	–	2	–	–	–	2	6
26-12-82	–	1	–	1	–	–	–	–	2	1	–	–	3	4
28-12-82	–	1	–	1	–	–	–	–	2	–	–	–	2	3
31-12-83	–	1	1	2	–	–	–	–	–	–	–	–	–	2
Total	42	110	127	279	40	21	22	57	79	44	19	40	322	601

*Adult specimens had undergone abortion.

Table 2

Monthwise collection of specimens

Month	No. of males	No. of females	Total
January	13	25	38
February	37	44	81
March	36	49	85
April	23	45	68
May	15	22	37
June	18	21	39
July	22	25	47
August	13	22	35
September	15	14	29
October	32	16	48
November	29	22	51
December	26	17	43
Total	279	322	601

processing. In the case of males the right testis and the right epididymis of each specimen were weighed with a Mettler balance after gently rolling the organs on a filter paper. While this does not give the exact weight of these organs, this method gives accurate relative values of the organs of the animals since the error due to fixation and preservation is same for all animals. The testis and accessory reproductive organs in the males and the ovaries, uterine cornua, vagina and mammary glands of the females were dehydrated by passing through graded ethanol, cleared in xylol, embedded in paraffin and cut at 8 to 10 μ thickness. For routine histological study the tissues were stained with Ehrlich's or Harris's haematoxylin and counterstained with eosin. Selected sections from each series were stained by the periodic acid-Schiff procedure (Pearse 1968), some by Mallory triple procedure and some by Heidenhain's Azan technique. All microscopic measurements were taken with the help of an ocular micrometer calibrated to a stage micrometer.

A detailed field diary and laboratory record have been maintained. Table 1 gives the date-wise details of the collections and Table 2 gives the monthwise collections of the specimens.

Observations and Discussion

A. *General remarks*

This species normally roosts in the space formed by groups of downward hanging, dried-up fronds of palm trees. The specimens emerge from their roosts about half an hour after sunset when there is still some twilight. Normally the specimens do not return to the roost until after feeding. However, during April and May the females were noticed to return now and then probably to give suck to the unweaned free young ones, which had been left behind in the roost, while the mothers went out foraging. This contention received additional support from the fact that many a female which was shot during April and May was in lactation, but had no young at their breasts.

An interesting feature about the roosting habits of these bats is that normally adult males roost separately from the females, and usually solitarily and rarely in groups of two or three except during the season of copulation. In fact, whenever a single specimen was noticed inside the hollows among the dried fronds, it was invariably a male. Juvenile males were, however, present among the females throughout the year.

Several newly delivered young ones were obtained during February to April and June and July — the two periods of delivery for this species The average weight of the young one at delivery was 11 g and this was also the average weight of the full term foetus. The young one gets a firm hold of one of the

mammary nipples of the mother soon after it is delivered. The teeth of the young were so firmly and deeply sunk in the wall of the nipple that it required considerable force to separate the young one from the mother although the latter was dead and the young was still alive. The young one is constantly carried by the mother even during flight for about 45 to 50 days by which time the young one reaches a body weight of 34 to 36 g. No young one above this weight was noticed to be adhering to the mother's nipple. Evidently, the young ones leave their mothers after attaining this weight, but continue to suck milk for some more days before they are finally weaned. This fact also suggests that there is community suckling for some time after the young ones leave the breast of their mothers since it is unlikely that the young ones are able to find out their own mothers after getting free and *vice-versa*. On a few occasions there were two young ones attached one to each nipple of the mother. Obviously, one of the young could not be belonging to the mother since invariably only a single foetus is borne by each mother during each cycle.

B. *Female genitalia*

Externally the female genital organs of *Cynopterus sphinx* are built on a typically bicornuate plan. The two uterine cornua are of equal size in the non-pregnant female and form a 'V' shaped structure, the two limbs of the 'V' forming an angle of about 60°. In adult specimens each cornu is 8-10 mm long. The Fallopian tube arises from the posterio-median aspect of the ovarian bursa adjacent to a slit-like opening of the bursa, and, after taking a simple loop around the cranial aspect of the ovarian bursa, opens a little behind the cranial tip of the uterus on each side. The vagina is 12 to 14 mm long and gives the female genitalia a 'Y' shaped appearance, the vagina forming the vertical limb of the 'Y'. The vulval opening is a transverse slit and occurs on a thick pad slightly elevated from the surface of the body. On sectioning, it becomes evident that the uterine cornua remain separate and there are two distinct cervical canals on the lateral sides of the long cervix which projects to about half the length of the vagina. The cervical canals open independantly subterminally on the two sides of the cervix. The cranial three-fourths of the cervix is attached to the dorsal wall of the vagina. Hence, the vagina appears to be partitioned into two chambers for some distance and the vaginal canal appears like a semi-circular cavity surrounding the cervix in transverse sectional views.

The mammary glands are located on the ventro-lateral sides of the thorax just a little posterior to the axilla. The nipples project laterally. During lactation each mammary gland extends almost to the axilla of the respective side. The nipples become extended and cornified during the first lactation ofter which they do not regress completely. Hence, even during the non-pregnant season the parous females can be distinguished from the non-parous ones by the nature of the mammary nipples.

C. *Breeding seasons*

Since the reproductive stage of the animals was the same during the two years when the animals were collected, only the date and the month are mentioned in the following descriptions except where the mention of the year is warranted by some special condition. The examination of Table 1 and the collection diary reveals that each female specimen experiences two pregnancies in quick succession, the first pregnancy occurring during October to March, and the second pregnancy, which overlaps the

lactation period of the first pregnancy, commences within a short period after parturition and continues until June-July. The period from July to October is the sexually quiescent anoestrous period. Not all the females in the colony conceive at the same time during the first cycle, and this is also reflected in the second cycle since deliveries do not occur synchronously in all the females. Hence, conceptions after parturition in February-March also occur on different days in different specimens in the colony. Hence, during any date or month the females were at different stages of gestation during both the cycles.

The second pregnancy is carried by the uterine cornu contra-lateral to that which carried the first pregnancy. This is evident from the fact that there were several females, in which, whereas one uterine cornu had not yet undergone complete involution, the contra-lateral cornu carried the foetus of the second cycle. Microscopic examination of the ovaries revealed that a large corpus luteum occupying almost the whole ovary persisted for a few days after delivery in February-March. This necessitated the production and release of the Graafian follicle in the opposite ovary. The corpus luteum of the second cycle also persisted for a few days after parturition in June-July and had undergone regression quickly thereafter. Hence, by the time the young one is weaned the two ovaries present the same histological picture after July, and follicles continue to develop in both the ovaries.

During each pregnancy cycle one of the uterine cornua carries a single embryo. Hence, a single young one is delivered each time. Two females with unmistakable pregnancy, as evidenced by the occurrence of a slightly swollen right uterine cornu in each, were obtained on 22nd October. From the stage of development of the embryo it was evident that the animals had conceived three or four days earlier. After this date more and more females in the colony had conceived. Every female in all the colonies was pregnant during January and February, but the embryo in the uterus varied in the stage of development in different specimens. This is as expected because the date of conception differed in different animals. The first delivered young one was obtained on 16th February, after which more and more females delivered their young. Evidently, gestation lasts for about 120 days allowing a margin of three or four days on either side. The last delivered young one of the first cycle was collected on 20th March. This specimen must have been conceived between 15th and 20th November of the previous calendar year taking the gestation period as being about 120 days.

The earliest second conception was noticed on 20th February, and the first newly born young of the second cycle was obtained on 21st June. This was probably one or two days old. This also gives a gestation period of about 120 days. The last date on which a newly born young of the second cycle was 16th July, and this must have been conceived about the middle of March.

The first free young weighing 34g was collected on 6th April. Assuming that this belonged to the group delivered in the first batch (that is, on 16th February), it becomes evident that this specimen was about 50 days old. However, the females continue to be in lactation for another 10 to 15 days more during which period the free young onces probably take suck periodically.

Examination of Table 1 reveals that, whereas during the first cycle 71 females among 99 carried the conceptus in the right cornu of the uterus, in the second cycle only 27 females among 81 carried the conceptus in the right

cornu. Further, in most of the females collected during February and March, while one cornu was still in the post-partum condition and had not completely involuted, the contralateral cornu carried an embryo. These facts taken along with the fact that a large corpus luteum of the first cycle persists for a few days after delivery and during early pregnancy of the second cycle suggest that there is a distinct alternation of the two sides of the female genitalia in the two cycles in the year. However, within a short time after parturition in June-July the two ovaries present a typically anoestrous condition. Microscopic examination of the two ovaries of the adult specimens and the non-parous females approaching their first cycle during August and September revealed that numerous follicles at various stages of development were present in both the ovaries. However, in most of the females collected during October the right ovary had distinctly outstripped the left in the development of the Graafian follicles. In both the ovaries the follicles develop concurrently up to the vesicular stage, but after this stage the development of the follicles becomes arrested in the left ovary in most of the specimens, and one of the follicles in the right ovary develops further and releases the ovum. This is why a large proportion of the females carry the concept in the right ovary in the first cycle during each year. The persistence of the corpus luteum of the first cycle for a few days after parturition necessitates the alternation of the two sides of the female genitalia during the two cycles in the year. Hence, in the second cycle there were more females carrying the embryo in the left uterus than the right and the relative proportion is nearly the reverse of the proportion of pregnancy in the two sides during the first pregnancy cycle.

D. *Growth and maturity*

The following descriptions pertain to the females only. It has already been shown that the newly born young one weighs about 11 g, and they are weaned when they attain a body weight of about 35 g about 40 to 45 days after birth. Figure 1 is a scatter diagram to show the body weight of the females collected on different dates, and the lines are drawn to indicate the growth rate. The females reach sexual maturity when they attain a weight of about 50 g — this being the lowest weight of a female carrying an early embryo in the uterine cornu. The growth curves indicate that the specimens born in February-March, reach this weight by July-August, that is about five months after birth, attain sexual maturity by the time of the onset of the breed-in season in October. Hence, these females conceive in October along with parous females. The females born in June-July also reach sexual maturity in November-December, when they are five months of age. These copulate and conceive in November-December. This was why there were a few-non-parous females in the colonies during October-November and there was not a single non-pregnant female available after November every female in the colony having conceived by this time. This also explains why different females were at different stages of pregnancy during January-March, and why parturition was not synchronous in all the females.

The growth pattern of the males and the age at sexual maturity have already been described (Gopalakrishna & Sandhu, *in press*). It has been shown that the males do not reach sexual maturity until they are at least 15 to 16 months of age for those animals delivered during February-March and about 19 to 20 months of age in the case of the animals born during June-July.

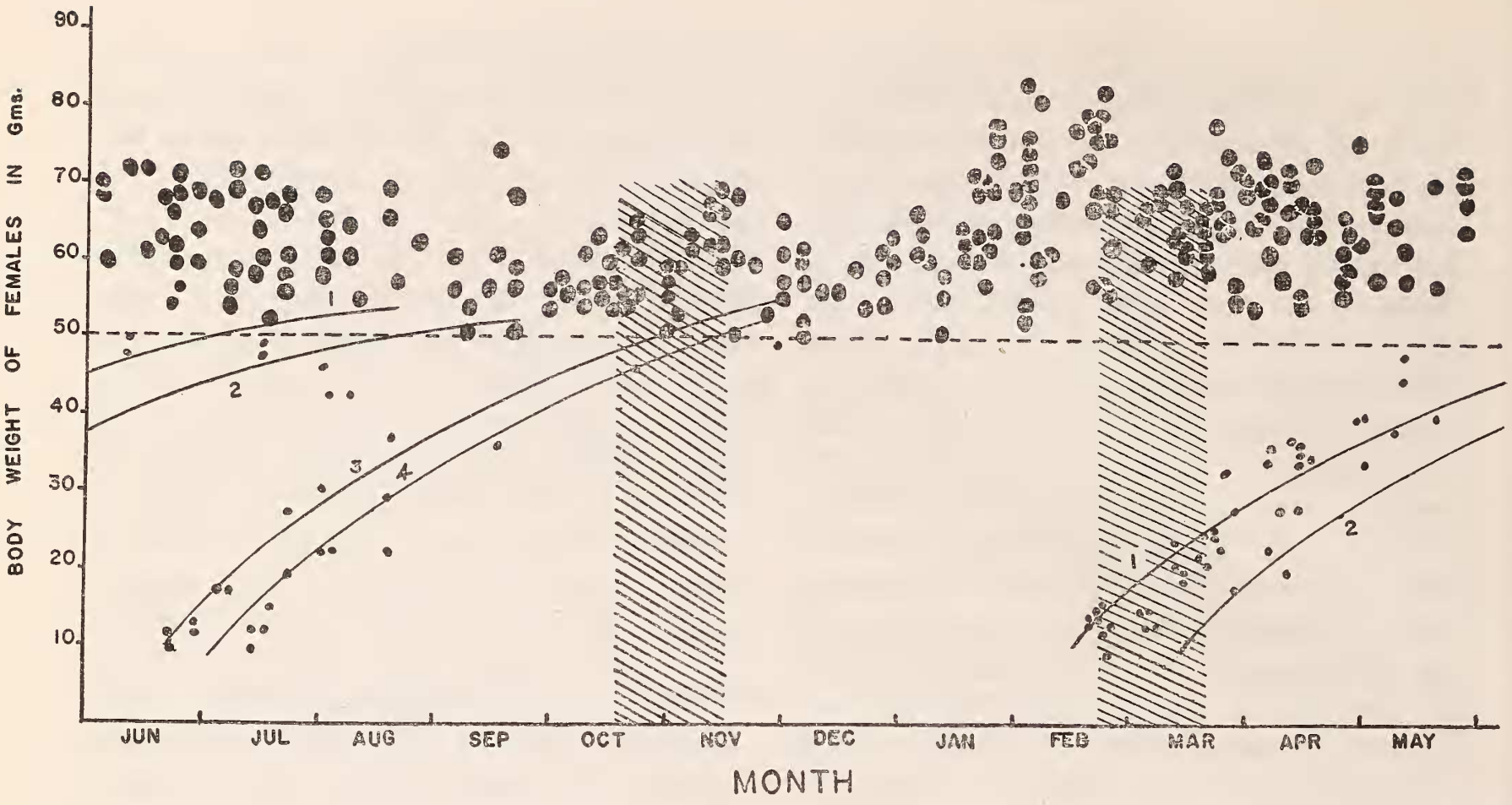

Fig. 1. Scatter diagram in which the body weights of the females are plotted against the dates of collection of the specimens. The dotted line indicates the body weight at sexual maturity. The curves indicate the manner of growth of the animals born during the two breeding cycles. Curves 1 and 2 relate to animals born on the earliest and the latest dates respectively in the first cycle (February-March). Curves 3 and 4 relate animals born in the second cycle (June-July). The shaded areas represent the periods when conception takes place. It is evident from the figure that animals born in February-March and also those born in June-July experience their first conception during October-November along with parous animals.

The fact that the number of young ones in the total population is so small indicates that there is considerable pre-pubertal mortality in this species. On several occasions, young ones with body weights ranging from 17 to 33 g had become accidentally freed from their mothers. These helpless young ones are an easy prey to predators like crows and hawks during the day time and owls and other nocturnal birds during the night.

E. *Sex Ratio*

Table 1 gives the data concerning the sex ratio of *Cynopterus sphinx* at different periods of life. From the table it is seen that among the 601 specimens studied during two years, when frequent random collections were made, 279 were males and 322 females. This gives a clear female-dominant sex ratio of 871 males to 1000 females in the total population. Among the 82 sucklings there was an almost equal number of males and females (42 and 40 respectively). Among 388 sexually mature adults there were 127 males and 261 females, giving a spectacular uneven sex ratio with

32.8% males and 67.2% females. However, in the pre-pubertal stage, not inclusive of the sucklings, the males far outnumber the females (110 males to 24 females). This is because of the difference in the age of attainment of sexual maturity between the two sexes. Whereas the females attain sexual maturity within 5 to 6 months of age, the males take at least 15 to 20 months to reach sexual maturity. Evidently, the overall female dominant sex ratio in the total population is due to a preferential mortality of the males during the growth period. On the basis of the present status of our knowledge it is not possible to assign any specific reason for the occurrence of uneven female dominant sex ratio among all the species of bats so far studied (Gopalakrishna & Madhavan 1978) except *Taphozous melanopogon* (Abdulali 1952). Probably genetic factors are responsible for making the males more susceptible to infection and diseases than the females thereby resulting in establishing an uneven female dominant sex ratio.

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